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(54) **ILLUMINATION SYSTEM FOR A DISPLAY APPARATUS**

(58) **Field of Search** 362/318, 322, 362/341, 335; 345/7, 8, 9; 359/630-636, 839; 353/98

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(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(52) **U.S. Cl.** **362/318; 362/335; 345/7; 359/630**

(57) **ABSTRACT**

An illumination system for a display apparatus is capable of reducing electric power consumption and lengthening a life span by minimizing a loss of marginal rays that are spaced away from a main optical axis. The minimum loss of the marginal rays is obtained by a light reflective surface of a predetermined degree of curvature formed on an optical device for diffuse-reflecting and altering an optical path of a light from a light source.

14 Claims, 1 Drawing Sheet

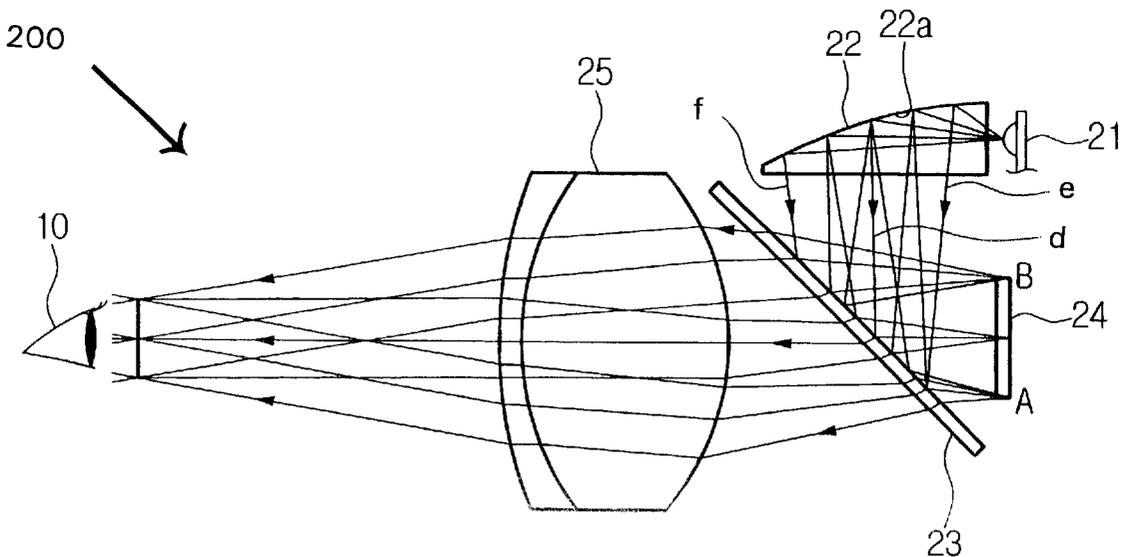


FIG. 1

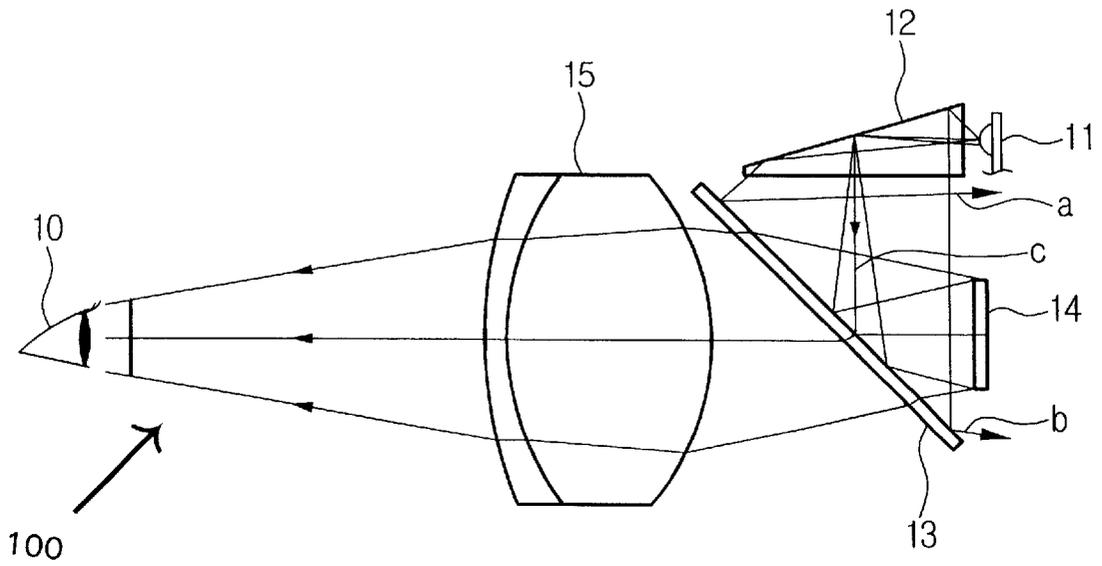
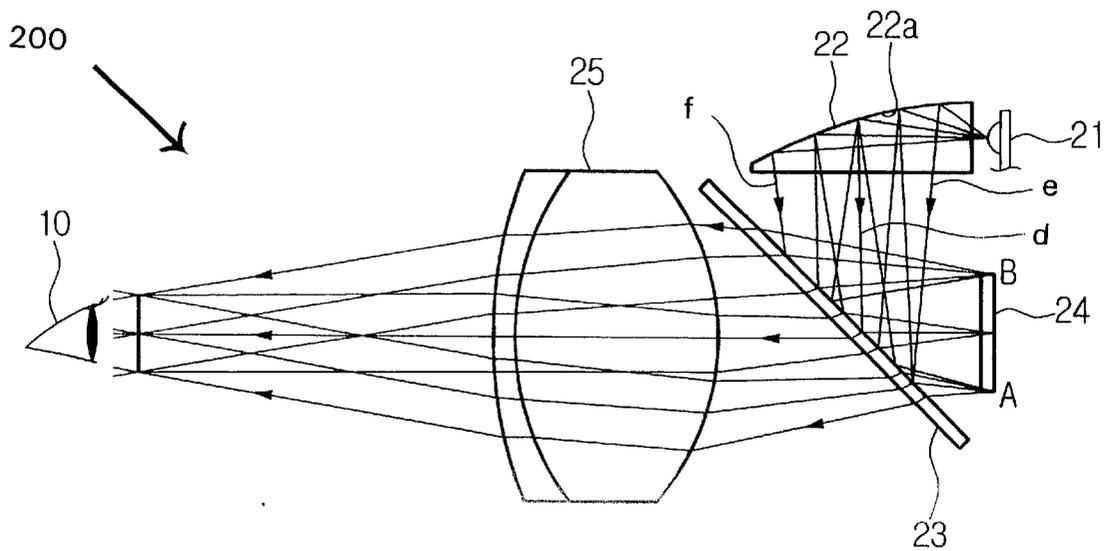


FIG. 2



ILLUMINATION SYSTEM FOR A DISPLAY APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Korean Application No. 2001-7339, filed Feb. 14, 2001, in the Korean Patent Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a display apparatus, and more particularly, to an illumination system for a display apparatus for use by an individual, such as a Head Mount Display apparatus (HMD).

2. Description of the Related Art

Generally, an HMD is mounted on a face or a head of a user in the form of eyeglasses or a helmet, for allowing the user to obtain image information. The HMD apparatus is a type of image displaying apparatus for individual use, which is usually used in Virtual Reality systems, flight simulators, etc. FIG. 1 illustrates a conventional head mount display apparatus **100**, in which light is emitted from a light source **11**, and an optical path thereof is altered by a series of optical units **12** and **13**. Accordingly, the light is condensed on an image generator **14** such as a liquid crystal display (LCD) or the like, generating an image which is magnified and projected on eyes **10** of an observer through a projected lens **15**.

The optical unit **12** diffuse-reflects the light emitted from the light source **11**, and alters the optical path thereof. The optical unit **12** can be a prism, a diffuse reflectance plate, or the like. The optical unit **13** reflects the light, which is diffuse-reflected by the optical unit **12** to a different optical path. By reflecting the light, the optical unit **13** condenses the light on the image generator **14**. optical unit **13** can be a polarization filter such as a polarizing beam splitter (PBS), or the like.

According to the conventional HMD apparatus **100**, since the prism or the diffuse reflectance plate that comprises the optical unit **12** has a planar light reflecting surface, marginal rays (a) and (b) of the light, which are spaced relatively far away from a main optical axis (c), are usually lost, and the optic efficiency is deteriorated.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to overcome the above-mentioned problems of the related art, and accordingly, it is an object of the present invention to provide an illumination system for a display apparatus, and more particularly, to provide an effective illumination system for a display apparatus for individual use, capable of reducing electric power consumption and lengthening a life span thereof through an improved light utilization efficiency.

Additional objects and advantages of the invention will be set forth in part in the description which follows, and, in part, will be obvious from the description, or may be learned by practice of the invention.

The above object is achieved with an illumination system for a display apparatus according to the present invention, including a light source; an image generator generating an image by using a light emitted from the light source; and an optical condenser having a light reflective surface condens-

ing the light emitted from the light source on the image generator by diffuse-reflecting the light. The light reflective surface of the optical condenser has a predetermined degree of curvature. According to the present invention, the optical condenser includes a reflecting mirror or a prism having a light reflective surface curved by a predetermined degree of curvature, diffuse-reflecting the light emitted from the light source and condensing the light on the image generator.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a schematic view showing a conventional illumination system for a head mount display apparatus; and

FIG. 2 is a schematic view showing an illumination system for a head mount display apparatus according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the present preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

Referring to FIG. 2, an illumination system **200** for a display apparatus for individual use includes a light source **21** such as a light emitting diode (LED) to generate and emit white light, a series of optical units **22** and **23** arranged to alter an optical path of the light emitted from the light source **21**, an image generator **24** such as a reflective liquid crystal display (LCD) for generating an image by using the light, and a projected lens **25** to magnify and project the image generated by the image generator **24** to the eyes **10** of the observer.

The optical unit **22** alters the optical path of the light emitted from the light source **21**, by diffuse-reflecting the light. As shown in FIG. 2, the optical unit **22** has a light reflective surface **22a**, that is formed to have a predetermined degree of curvature.

Among the light emitted from the light source **21**, marginal rays (e) and (f), spaced from a main optical axis (d), are incident on outer areas A and B of the image generator **24**, respectively. Accordingly, even the marginal rays (e) and (f), that are remotely incident at a predetermined angle with respect to the main optical axis (d) are mostly condensed on the image generator **24**. As a result, the amount of lost rays can be reduced, while the light utilization efficiency can also be improved by a uniform illumination.

According to the present invention, the optical unit **22** can be a prism, a diffuse reflectance plate, a reflecting mirror, or the like. Also, the light reflective surface **22a** of the optical unit **22** can have various degrees of curvature corresponding to relevant environments, such as a size of the image generator **24**, or the like. The optical unit **22** condenses the light on the optical unit **23**. The optical unit **23** reflects the light that is diffuse-reflected by the light reflective surface **22a** of the optical unit **22**, and accordingly condenses the light on the image generator **24**. The optical unit **23** can be a PBS.

According to the illumination system **200** for the display apparatus, the light emitted from the light source **21** is diffuse-reflected by a concave light reflective surface **22a** of

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the optical unit 22, and accordingly the optical path of the light is shifted. While some rays are passed, other rays are reflected by the optical unit 23 and are incident on the image generator 24, including the marginal rays (e) and (f). The image generator 24 emits the image, which is generated by using the condensed light, to pass through the optical unit 23 and on an optical incident surface of the projected lens 25 so that the projected lens 25 magnifies and projects the image to each of the eyes 10 of the observer.

As described above, in the illumination system 200 for the display apparatus for individual use according to the present invention, due to the optical unit 22 having the light reflective surface 22a of a predetermined degree of curvature, which alters the optical path of the light by diffuse-reflection, the loss of marginal rays that are spaced away from the main optical axis can be reduced, while the light utilization efficiency is considerably increased due to uniform illumination. As a result, the electric power consumption can be reduced, and the life span of the parts can be lengthened.

Although a few preferred embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. An illumination system for a display apparatus, comprising:
 - a light source emitting light;
 - image generator for generating an image using the light emitted from the light source; and
 - optical unit having a light reflective surface for condensing the light emitted from the light source on the image generator by diffuse-reflecting the light, the light reflective surface of the optical unit having a predetermined degree of curvature.
2. The illumination system of claim 1, wherein the optical unit is a reflecting mirror.
3. The illumination system of claim 1, wherein the optical unit is a prism.
4. The illumination system of claim 1, wherein the image generator is a reflective liquid crystal display (LCD).
5. A system comprising:
 - a light source to emit a light;
 - an image generator to generate an image by using the light; and
 - an optical condenser having a curved light reflective surface to condense the light emitted from said light source on said image generator,

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the light condensed on said image generator having a uniform illumination.

6. The system of claim 5, wherein said optical condenser condenses the light by diffuse-reflecting the light.

7. The system of claim 5, wherein said light reflective surface has a predetermined degree of curvature.

8. The system of claim 7, wherein the predetermined degree of curvature corresponds to a size of said image generator.

9. A system comprising:

a light source to emit a light;

an image generator to generate an image by using the light;

an optical condenser having a curved light reflective surface to condense the light emitted from said light source on an optical reflector by diffuse-reflecting the light; and

a projected lens,

the light on the image generator being reflected through said optical reflector and focused by said projected lens on an eye of the user.

10. The system of claim 5, wherein said light reflective surface is concave.

11. The system of claim 6, further comprising an optical reflector in an optical path of the light between said optical condenser and said image generator, wherein said optical condenser condenses the light on said optical reflector, and said optical reflector reflects the light onto said image generator.

12. The system of claim 11, wherein the optical reflector is a polarizing beam splitter (PBS).

13. A method to generate an image, comprising:

emitting light; and

condensing the light on an image generator with an optical condenser having a curved surface,

the light condensed on said image generator having a uniform illumination.

14. A head mount display comprising:

a light source to emit a light;

an image generator to generate an image by using the light; and

an optical condenser having a curved light reflective surface to condense the light emitted from said light source on said image generator by diffuse-reflecting the light.

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